(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 297 552 B1**

(12) EUROPEAN PATENT SPECIFICATION

(45) Date of publication of patent specification: **01.12.93**

(51) Int. Cl.^{5}: **B23P 11/00**

(21) Application number: **88110394.9**

(22) Date of filing: **29.06.88**

Divisional application 92110490.7 filed on 29/06/88.

(54) **Composite structures and methods of manufacturing the same.**

(30) Priority: **01.07.87 JP 164848/87**
01.07.87 JP 164849/87
01.07.87 JP 164850/87
01.07.87 JP 164851/87
01.07.87 JP 164852/87

(43) Date of publication of application:
04.01.89 Bulletin 89/01

(45) Publication of the grant of the patent:
01.12.93 Bulletin 93/48

(84) Designated Contracting States:
DE FR GB IT NL

(56) References cited:
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Description

This invention relates to a composite structure and to a method of manufacturing a composite structure according to the pre-characterizing part of claim 1 and 7, respectively. Such structure and method are known from FR-A-872 779.

In connection with the linear motor car for example, a structure of a secondary plate, which functions to produce eddy current, in a primary side of the motor car for producing a driving force, must be used on the railway track. Such secondary plate is required to have high electric conductivity and magnetic permiability as well as a great resistance against shearing forces and separating forces which are generated as counter forces against the great driving force. Therefore, a composite structure fabricated by tightly and firmly joining materials of different kinds having a high electric conductivity and a high magnetic permiability, respectively, is utilized as the secondary plates.

For example, there are known composite structures fabricated by fixedly joining face to face an aluminum plate having a high electric conductivity on a soft steel plate having a high magnetic permiability. In an example of such composite structures, the aluminum plate is press-fitted at the opposite ends thereof on the two end surfaces of the soft steel plate, and fastening screws are passed through the aluminum plate into the soft steel plate to mechanically join both the plates as a combined metallic structure. In another example, a composite structure is obtained by joining the aluminum plate to the soft steel plate by an explosion bonding method into an explosion bonded clad plate.

However, as described hereinbefore, it is required for the secondary plate to possess a mechanical strength against the strong reacting forces to the driving force, acting frequently and repeatedly, and accordingly, the secondary plate must have a large resistance against shearing forces along the interface between the two elementary plates as well as against vertical separating forces imparted to the two elementary plates of the secondary plate. Particularly, when a composite structure is applied to the railway track of a subway, it is required for the composite structure to have mechanical strength or resistance against additional thermal behavior and separating forces due to temperature variations and dynamic vibrations. However, the composite structures fabricated by press-forming the two plates and then clamping by fastening screws or fabricated by the explosion bonding method cannot maintain sufficient resistance for a long period of time.

The above mentioned FR-A-872 779 teaches to join one material with another material by plastically forcing the one material into grooves of the other material. To this end, the one material is provided with protrusions corresponding to said grooves.

US-A-4722 125 discloses a method of producing a tungsten carbide tip punch having cylindrical form. The hard tungsten carbide tip has a crown-like indentation having arched vertices, and a cylindrical portion of a soft material is forced into said indentation.

Accordingly, an object of this invention is to provide a composite structure of the above-mentioned type which is capable of maintaining for a long time firm mechanically joined condition of the different materials without causing relative shifting and separation of the joined surfaces of the materials even when the composite structure is exposed to an environment in which repeatedly acting strong shearing stresses and violent thermal behavior are imparted to the composite structure.

This object can be achieved in accordance with the characterizing part of claim 1. Claim 7 defines a method for manufacturing such structure.

The composite structure thus manufactured can provide a firm mechanically joined condition between the first and second materials by virtue of the firm engagement of the overhang surface of the recess of the first material with the underhang surface of the protrusion of the second material.

BRIEF DESCRIPTION OF THE DRAWINGS

In the accompanying drawings:

Fig. 1A is a cross sectional view of one embodiment of a composite structure comprising materials of different kinds according to this invention;

Fig. 1B is a cross sectional view of the materials, shown as being separated, of the composite structure shown in Fig. 1A;

Fig. 2 is a cross sectional view of another embodiment of the composite structure according to this invention;

Fig. 3 is a cross sectional view of a first material in which a recess is to be formed;

Fig. 4 is a cross sectional view showing a step to form a recess in the material shown in Fig. 3;

Fig. 5 is a cross sectional view representing a next step subsequent to the step shown in Fig. 4 to form the recess;

Fig. 6 is a cross sectional view showing a step to form a recess having a cross-sectional shape different from that shown in Fig. 4 in the material shown in Fig. 3;

Fig. 7 is a cross sectional view showing a next step subsequent to the step shown in Fig. 6 to form the recess;

Fig. 8 is a cross sectional view representing a step to form a recess in a surface of a first material of a composite structure according to a still further embodiment of this invention;

Fig. 9 is a plan view showing a portion of the first material in which a recess is formed by the step shown in Fig. 8;

Fig. 10 is a cross sectional view of one of materials constituting a composite structure;

Figs. 11 and 12 are cross sectional views showing successive steps subsequent to the step shown in Fig. 10;

Figs. 13 to 15 are cross sectional views illustrative of steps in sequence of forming recesses in a first material constituting a composite structure, according to a method of this invention;

Figs. 16 to 20 are views explanatory of steps in sequence of forming a composite structure by a casting method for joining two different materials;

Figs. 21 to 24 are views explanatory of steps in sequence of joining two different materials due to plastic flow of a first material to form a composite structure; and

Figs. 25 to 29 are views explanatory of other steps in sequence of joining two different material due to plastic flow of a first material to form a composite structure.

Preferred embodiments of this invention will be described hereunder with reference to a secondary plate of an iron track for a linear motor car railway in conjunction with the accompanying drawings.

Fig. 1A shows an embodiment of this invention in the form of a secondary plate 111 of an iron track, formed as a composite structure made of materials of dissimilar or different kinds. The composite structure comprises a soft steel plate 2 as a first material having a high magnetic permiability, and an aluminum plate 3 as a second material having a good electric conductivity and disposed on the soft steel plate 2, both plates 2 and 3 being joined mechanically along an interface 11.

Fig. 1B shows the composite structure in a state wherein the two plates 2 and 3 are separated. As is apparent from Fig. 1B the steel plate 2 is provided with an upper joining surface 11a in which are formed a plurality of grooves or recesses 7 each converging downwardly in cross section to form a V-shape and each being obliquely oriented so as to have one side surface 6 constituted as an overhang surface, which protrudes horizontally as it extends upwards as viewed in Fig. 1B. The angle of the oblique direction and the arrangement of the grooves 7 may be changed or modified in accordance with conditions of design.

The aluminum plate 3 is provided with a lower joining surface 11b on which are formed a plurality of projections or protrusions 9 each converging downwardly in cross section to form a V-shape and each obliquely projecting obliquely so as to have one side surface 8 constituted as an underhang surface which protrudes horizontally as it extends downwards as viewed in Fig. 1B.

The locations and shapes of the grooves 7 of the steel plate 2 are made to accord with those of the corresponding projections 9 of the aluminum plate 3 in the joined state. Although, in the illustration of Fig. 1B, the plates 2 and 3 are separated, actually these plates 2 and 3 are firmly mechanically joined together in the manufacturing process of the composite structure 111 according to this invention, for example, by casting the projections into the grooves 7 or by pressing the plate 3 against the plate 2 by means of a pressing roll to establish firm engagement of the projections 9 with the corresponding grooves 7 as described in detail hereafter.

The composite structure 111 can thus be formed integrally as one body with extremely high joining force and resistance aginst shearing forces in both the longitudinal and transverse directions, as well as against vertical separating forces based on the thermal behavior due to temperature changes.

With the composite structure of the character described above, in a case where a linear motor car, not shown, travels above the secondary plate 111 with a predetermined height of floatation, eddy currents are generated through the aluminum plate 3, which produces a driving force for the linear motor car. During the travel of the car, the aluminum plate 3 receives a large reaction force as a result of the driving force in the longitudinal direction thereof. However, because of great resisting forces aginst the reaction forces and the shearing forces in a direction normal to the longitudinal direction and because of a great resistance in a vertical direction as viewed in Fig. 1A against separation of the two plates due to the strong mechanical engagement between the overhang surfaces 6 of the grooves 7 of the steel plate 2 and the underhang surfaces 8 of the projections 9 of the aluminum plate 3, the secondary plate is prevented from shifting in height more than a designed allowable change in height. In addition, the tight joining along the interface between the steel plate 2 and the aluminum plate 3 can positively prevent the possibility of corrosion which may be caused by salty sea winds or submergence by flooding and so on, whereby the two plates are prevented from separating, constantly maintaining the bonded condition originally designed, thereby enabling a linear motor car to travel as designed.

Fig. 2 shows another embodiment of a composite structure 112 according to this invention, in which all grooves or recesses 7 formed in the

upper joining surface of the steel plate 2 have therein intermediate ridges or projections 10 directed upwardly to enlarge the joining surface area of the grooves 7 to thereby increase the resistance against the shearing forces. The composite structure 112 according to this embodiment is advantageous in that the projections 10 make easy plastic flows of the material of the aluminum plate 3 into the recesses 7, when the material of the plate 3 is to be pressed into the recesses 7, thus enabling better charging of the material of the plate 3 in the recesses 7.

It should be noted that the composite structures of this invention have been described hereinbefore with reference to the preferred embodiments, but it is not limited to these embodiments and other various changes or modifications may be made. For example, ridges or grooves may be formed in zigzag shape on the underhang surfaces and overhang surfaces in plural stages in the direction of height of the protrusions and of the depth of the recesses, respectively. Further, the soft steel plate 2 and the aluminum plate 3 may be replaced with other metallic plate members of different kinds, respectively.

Moreover, the composite structures according to this invention can be used not only as a secondary plate of a linear motor car track but also as composite structures requiring firm engagement between two plates or members, for example, for use in motor cars, machine tools, or as composite structures which are used under severe, violent conditions accompanied by sliding movements, vibrations or temperature variations.

According to the composite structures of the characters described above, a firm engaging state between two materials can be maintained stably even under great, frequently repeated shearing and separating forces imparted to the composite structures, with the result that the function or operation of a linear motor car, for instance, can be stably maintained as designed. In addition, the joining surfaces of the two metal plates are kept in tightly bonded state in a manner of a labyrinth seal, so that separation of the two materials does not occur and any corrosive substance does not intrude to the interface even if the composite structure is exposed to corrosive atmosphere.

The formation of the V-shaped grooves 7 having overhang surfaces 6 in the joining surface of the soft steel plate 2 can be made in accordance with methods described hereunder with reference to the accompanying drawings.

In a first method, a blank soft steel plate 2 having a flat joining surface 11a to be bonded or joined, as shown in Fig. 3, is first prepared, and a formation roll 10 having flat opposite side surfaces and a circumferential surface provided therearound with a ridge formed so as to define a predetermined tapered peripheral surface is pressed with a predetermined pressure against the planar joining surface 11a of the steel plate 2 as shown in Fig. 4. When the formation roll 20 is rolled under the pressing condition, a sharply raised portion 24 is formed on the joining surface 11a at one side of the roll 20, as shown in Fig. 4, and simultaneously, a valley portion 25 and a slightly raised portion 26 are also formed below the formation roll 20 and at the other side thereof, respectively. A valley portion 25 flanked by the raised portion 24 of a predetermined height is formed by repeating the pressing process described above by means of the formation roll 20.

In the next step, as shown in Fig. 5, when a cylindrical levelling roll 27 is rolled on the joining surface 11a in which the valley portion 25 has been formed by the pressing operation, the raised portions 24 and 26 are made flat so as to accord with the level of the other general portion of the joining surface 11a, whereby a V-shaped groove or recess 7 having the overhang surface 6 can be thus formed without carrying out a troublesome and difficult machining for cutting a sloping V-shaped groove.

A method of formation of a groove 7 having such a shape as shown in Fig. 2 will be described with reference to Fig. 6. In this method, a pulley-type formation roll 20a is pressed against the joining surface 11a of the blank soft steel plate 2 shown in Fig. 3. When the formation roll 20a is rolled on the joining surface 11a while pressing the same, a groove having an intermediate ridge 28, substantially vertical side walls and raised portions 29 is formed, and by repeating the rolling steps, a V-shaped valley portion for the groove and the raised portions 29 each having a predetermined height are formed.

In the next step, when a cylindrical formation roll 27a is rolled by a predetermined number of revolution on the valley portion of the joining surface 11a, the raised portions 29 are pressed into a flat state, and a groove having overhang surfaces 6 sloping outwards with respect to the ridge portion 28 can be formed.

Fig. 8 is explanatory of a further method of forming grooves 7 in the joining surface of the steel plate 2. In this method a pulley-type formation roll 20a similar to that shown in Fig. 6 is utilized. A plurality of depressions30 are formed in the outer surface of the roll 20a so as to extend in the axial direction in circumferentially equally spaced relation. When the formation roll 20a is rolled on the joining surface of the steel plate 2, protrusions 31 are formed at equal intervals on the bottom of the groove 7 as shown in Fig. 25. Instead of the depressions 30, protrusions may be provided. In

this case, depressions are formed in the bottom of the groove 7.

According to this embodiment, the projections of the aluminum plate 3 can be firmly engaged with the protrusions 31 when the aluminum plate 3 is joined with the steel plate 2, and accordingly, resistance of the grooves 7 against external forces in the longitudinal direction thereof is increased.

The formation of the groove 7 or the projection 9 having a dovetail cross-sectional shape can be made in a manner shown in Figs. 10 to 12. A blank soft steel plate 2 having an upper joining surface 11a with a projection 40 preliminarily formed to have a rectangular cross section is first prepared. A formation roll 41 having therearound a groove of a substantially M-shaped cross section, as shown in Fig. 27, is pressed and rolled against the projection 40 in such a manner that the inner side walls of the M-shaped groove abut against the side walls of the projection 40. The formation roll 41 is rolled under the pressing condition by a predetermined number of revolution to plastically form the projection 40 into a M-shaped projection 40'. In the next step, a formation roll 42 having a cylindrical configuration is pressed against the M-shaped projection 40' and rolled by a predetermined number of revolution to form a projection 40" having an upper flat surface and overhang surfaces 43 on both sides thereof, whereby the projection 40" has a dovetail shape in cross section. According to this forming method, the dovetail-shaped projection can be easily formed as designed without carrying out a troublesome cutting work.

As will be easily understood, a dovetail-shaped projection having underhang surfaces on both sides thereof to be engageable with the overhang surfaces 43 of the steel plate 2 can be formed on the joining surface of the aluminum plate 3 in substantially the same manner as that described with reference to the formation of the dovetail-shaped projection 40" of the steel plate 2.

Figs. 13 to 15 are explanatory of another method of forming grooves, in the joining surface of the steel plate. According to this method, as shown in Fig. 13, a formation roll provided with annular roll portions 45 having a substantially rectangular cross-sectional shape is pressed against and then rolled on the joining surface 11a of the steel plate 2 to effect plastic working and to form grooves therein with raised portions 46 on both sides thereof.

In the next step, as shown in Fig. 14, a roll 48 provided with circumferential grooves 47 of a substantially triangular cross section at portions corresponding to the locations of the grooves 7 of the steel plate 2 formed by the formation roll 45 is pressed and rolled so as to plastically deform the raised portions 46 towards the insides of the grooves 7 as denoted by the reference numeral 46'. In the final stage, as shown in Fig. 15, when a formation roll 49 having a cylindrical configuration is pressed against and rolled on the joining surface 11a, the raised portion 46' are further deformed inwardly to thereby form the grooves 7 each having the overhang surfaces 6 on both sides.

In order to fabricate the composite structure of the character shown in Fig. 2, for example, the grooves 7 having the overhang surfaces 6 are first formed in the upper surface and, in a certain case, in both side surfaces, of the soft steel plate 2 as shown in Fig. 16, and thereafter, a pair of the thus prepared metal plates 2 are integrally bonded at the opposing back surfaces thereof through a release agent 63 such as plaster, as shown in Fig. 17, for the purpose of mass production of the composite structure. The thus bonded steel plates 2 are then placed in a casting mold 65 as shown in Fig. 18 and a molten aluminum bath 3' is poured through a gate 67 of the mold 65 into a cavity defined between the inner wall of the mold 65 and the outer joining surfaces and the side surfaces of the bonded steel plates 2. During this process, a care must be taken for entirely and completely charging the molten aluminum bath 3' over the entire overhang surfaces 6 of the grooves 7 of the steel plates 2.

The mold 65 is opened, after a predetermined time has elapsed to cool and coagulate the aluminum molten bath 3', to obtain a block in which the aluminum material 3 covers the entire outer surfaces of the steel plates 2 and is completely charged into all of the grooves 7 of the steel plates 2 along the overhang surfaces 6 thereof, as shown in Fig. 19. The block is then cut along the release agent 63 to obtain secondary plates such as shown in Fig. 20.

In the embodiment described above, an anti-corrosion coating process can be interposed between the processes or steps carried out with reference to Figs. 17 and 18 to form a corrosion proof film made of an insulating material for preventing electrolytic corrosion between the steel and aluminum materials, on the joining surface between the steel plate 2 and the aluminum plate 3. The coated steel plates 2 are thereafter placed in the mold 65 and the molten aluminum bath 3' is poured into the mold cavity in the same manner as described before.

It should be course be understood that one of the two different materials which is more easily fusible than the other can be fused and poured into the mold in the molding process described hereinbefore.

Firm bonding or joining between the steel plate 2 and the aluminum plate 3 may be performed by a method utilizing plastic flow described hereunder.

Before carrying out this method, a soft steel plate 2 with a joining surface 11a having grooves 7 provided with overhang surfaces 6, as shown in Fig 21, is first prepared, while a flat aluminum plate 3 having a joining surface 11b as shown in Fig. 22 is prepared.

The thus prepared plates 2 and 3 are superimposed with their joining surfaces 11a and 11b opposed as shown in Fig. 23 and the two plates are pressed entirely uniformly by means of a pressing device or rolling device, not shown, in the arrowed direction F.

The application of the pressure in the direction F causes plastic flow of the aluminum material forming the joining surface 11b of the aluminum plate 3, which has a yielding point lower than that of the steel plate 2, into the grooves 7 thereof, and continuous application of the pressure causes the aluminum material of the joining surface 11b to completely fill the grooves 7 along the entire overhang surfaces 6 thereof to achieve firm engagement of both the plates 2 and 3, which is maintained even after the pressing force has been released.

The plastic flow of the material of the aluminum plate 3 into the grooves 7 of the steel plate 2 will be assisted by heating the joining surface 11b of the aluminum plate 3 by means of a high frequency heating device, for example, during the pressure application process.

A final product can be obtained by carrying out a trimming operation on the thus obtained composite block of the plates 2 and 3.

The composite structure 112 shown in Fig. 2 can also be manufactured by a method described below with reference to Figs. 25 to 29.

According to this manufacturing method, a soft steel plate 2 having a joining surface 11a in which grooves 7 provided with overhang surfaces 6 are formed preliminarily is first prepared as shown in Fig. 25, while an aluminum plate 3 having a joining surface 11b on which projections 66 are preliminarily formed at positions corresponding to the grooves 7 as shown in Fig. 26 is prepared. The tip end of each projection 66 is formed with a groove 67 of V-shaped cross section. This shape of the projections 66 is substantially the same as the projection 40' formed in the process step shown in Fig. 11. The aluminum plate 3 of Fig. 26 can be obtained as a section of the desired profile available in the market. It is desirable that the volumetric amount of each projection 66 on the joining surface 11b be slightly greater than the volumetric amount of each groove 7 of the steel plate 2.

In the next step, as shown in Fig. 27, the aluminum plate 3 and the metal plate 2 are arranged to oppose to each other so as to achieve a positional alignment of the corresponding projections 66 and grooves 7, respectively. Thereafter, the tip end of each projection 66 is fitted into each groove 7 as shown in Fig. 28, and a pressing force F is applied uniformly to the entire aluminum plate 3 towards the metal plate 2 by means of a pressing device or rolling device. The application of the pressing force F causes plastic flow of the aluminum material forming the projections 66 of the aluminum plate 3 as described with reference to the former embodiment, and the aluminum material of the projections 66 is charged into the grooves 7 of the steel plate 2 along the entire overhang surfaces 6 as shown in Fig. 28.

During this pressure application process, the plastic flow of the aluminum material into the grooves 7 along the overhang surfaces 6 can be more effectively achieved by a cotter function due to the presence of the inclined surfaces of projections formed on the bottoms of the grooves 7. In addition, the plastic flow of the material of the aluminum plate 3 upon the application of the pressing force F can be attained more precisely due to the fact that the volumetric amount of each projection 66 on the joining surface 11b of the aluminum plate 3 is designed to be slightly greater than the volumetric amount of the corresponding groove 7, whereby firm mechanical engagement between the aluminum plate 3 and the steel plate 2 is realized.

The plastic flow of the aluminum material can be effected more precisely by heating the projections 66 to a predetermined temperature to reduce the yielding stress of the aluminum plate 3 during the pressure applying process as described with reference to the former embodiment. Furthermore, even after the projections 66 has contracted due to the cooling during the pressure applying process, complete filling of the aluminum material in the grooves is attained since the volumetric amount of the projections 66 is made slightly greater than that of the grooves 7. That is, the flow of the aluminum material into the grooves 7 after the contraction can be achieved without leaving vacant spaces or gaps therebetween, thus enabling to attain firm mechanical engagement between the aluminum plate 3 and the steel plate 2.

In the thus manufactured composite structure, since the joining area of the aluminum plate 3 to the soft steel plate 2 is enlarged, the composite structure can be endowed with a strong resisting force against the horizontal shearing displacement and the vertical separating displacement.

Claims

1. A composite structure made from a pair of plate members mechanically joined together, comprising:

   a first plate member (2) provided with a first

planar joining surface (11a) having therein grooves (7) distributed over the surface, at least some of said grooves (7) having opposite overhang side surfaces (6); and
a second plate member (3) provided with a second planar joining surface (11b) joined face to face to said first joining surface (11a), said second joining surface having integrally thereon protrusions (9) plastically forced into said respective grooves (7) to fill and firmly engage therewith,
characterized in that
said second plate member (3) is made of a material softer than the material of the first plate member (2), that at least some of the grooves (7) are formed to have an intermediate ridge (28) on the bottom of the groove, said ridge (28) having opposite sloping side surfaces to define with said overhang side surfaces (6) a pair of grooves of V-shaped cross-section, extending into the first plate member (2) obliquely in directions away from each other, and the protrusions of the second plate member (3) comprise protrusions (9) converging downwardly in cross section to form a V-shape and projecting into corresponding grooves (7).

2. The composite structure according to claim 1, **characterized in that** said grooves (7) and ridges are formed on the surfaces thereof with fine recesses and protrusions in wave form.

3. The composite structure according to claim 1, **characterized in that** said joining surfaces of said first and second palte members (2,3) are formed at least partially with fine recesses and protrusions in wave form.

4. The composite structure according to claim 1, **characterized in that** said joining surfaces, inner surfaces of said grooves (7) and outer surfaces of said ridges are joined to each other with a thin film (11) interposed therebetween.

5. The composite structure according to claim 4, **characterized in that** said thin film is a corrosion proof coating.

6. The composite structure according to claim 1, **characterized by** comprising wave-shaped side edges (16) formed along the opening of each of said grooves (7) as extensions of said first joining surface.

7. A method of manufacturing a composite structure made from a pair of plate members (2,3) mechanically joined together, comprising the steps of:
preparing a first plate member (2) provided with a first planar joining surface (11a) having therein grooves (7) distributed over the surface, at least some of said grooves (7) having opposite overhang side surfaces (6);
preparing a second plate member (3) provided with a second planar joining surface (11b) having protrusions integrally thereon;
opposing said first and second joining surfaces (11a,11b) of the first and second plate members, and pressing the second plate member (3) against the first plate member (2) to cause plastic flow of the material of the second plate member into the grooves (7) of the first plate member (2) to fill the grooves with the material of the second plate member,
characterized in that
the second plate member (3) of a material softer than the material of the first member (2) is provided, wherein said protrusions (9) converge downwardly in cross section to form a V-shape, and an intermediate ridge (28) having opposite sloping side sur-faces is formed on and along the bottom of said some of the grooves (7) so as to define a pair of grooves of V-shaped cross-section, extending into the first plate member obliquely in directions away from each other, and that said plastic flow of the softer material of the second plate member (3) into each groove (7) is divided into two flows into said pair of grooves of V-shaped cross-section, as a result of said pressing of the second plate member (3), under guidance of said opposite sloping side surfaces of the ridge (28).

Patentansprüche

1. Verbundstruktur aus einem Paar mechanisch miteinander verbundener Plattenelemente, mit:
einem ersten Plattenelement (2), das mit einer ersten planaren Verbindungsfläche (11a) mit darin ausgebildeten, über die Fläche verteilten Nuten (7) versehen ist, wobei wenigstens einige der Nuten (7) einander gegenüberliegende Überhang-Seitenflächen (6) aufweisen; und
mit einem zweiten Plattenelement (3), das mit einer zweiten planaren Verbindungsfläche (11b) versehen ist, die flächig mit der ersten Verbindungsfläche (11a) verbunden ist, wobei auf der zweiten Verbindungsfläche in integraler Weise Vorsprünge (9) ausgebildet sind, die plastisch in die jeweiligen Nuten (7) gedrängt sind und diese ausfüllen sowie einen festen

Eingriff mit diesen herstellen,
dadurch gekennzeichnet,
daß das zweite Plattenelement (3) aus einem weicheren Material als das Material des ersten Plattenelements (2) gebildet ist, daß wenigstens einige der Nuten (7) mit einer mittleren Rippe (28) auf dem Boden der Nut ausgebildet sind, wobei die Rippe (28) einander entgegengesetzte, schräg verlaufende Seitenflächen aufweist, um zusammen mit den Überhang-Seitenflächen (6) ein paar Nuten V-förmigen Querschnitts zu bilden, die sich schräg in Richtung voneinander weg in das erste Plattenelement (2) hineinerstrecken, und daß die Vorsprünge des zweiten Plattenelements (3) Vorsprünge (9) aufweisen, die zur Bildung einer V-Form im Querschnitt nach unten konvergieren und in die entsprechenden Nuten (7) hineinragen.

2. Verbundstruktur nach Anspruch 1,
dadurch gekennzeichnet,
daß die Nuten (7) und die Rippen auf ihren Oberflächen mit feinen Vertiefungen und Vorsprüngen in Wellenform ausgebildet sind.

3. Verbundstruktur nach Anspruch 1,
dadurch gekennzeichnet,
daß die Verbindungsflächen des ersten und des zweiten Plattenelements (2,3) wenigstens teilweise mit feinen Vertiefungen und Vorsprüngen in Wellenform ausgebildet sind.

4. Verbundstruktur nach Anspruch 1,
dadurch gekennzeichnet,
daß die Verbindungsflächen, die Innenflächen der Nuten (7) und die Außenflächen der Rippen unter Zwischenordnung einer dünnen Schicht (11) miteinander verbunden sind.

5. Verbundstruktur nach Anspruch 4,
dadurch gekennzeichnet,
daß es sich bei der dünnen Schicht um eine korrosionsbeständige Beschichtung handelt.

6. Verbundstruktur nach Anspruch 1,
dadurch gekennzeichnet,
daß sie wellenförmige Seitenränder (16) aufweist, die entlang der Öffnung einer jeden der Nuten (7) als Verlängerungen der ersten Verbindungsflächen ausgebildet sind.

7. Verfahren zum Herstellen einer Verbundstruktur aus einem Paar mechanisch miteinander verbundener Plattenelemente (2,3), mit folgenden Schritten:
Vorbereiten eines ersten Plattenelements (2), das mit einer ersten planaren Verbindungsfläche (11a) mit darin ausgebildeten und über die Fläche verteilten Nuten (7) versehen ist, wobei wenigstens einige der Nuten (7) einander gegenüberliegende Überhang-Seitenflächen (6) aufweisen;
Vorbereiten eines zweiten Plattenelements (3), das mit einer zweiten planaren Verbindungsfläche (11b) mit darauf in integraler Weise ausgebildeten Vorsprüngen versehen ist;
gegenüberliegendes Anordnen der ersten und der zweiten Verbindungsfläche (11a, 11b) des ersten und des zweiten Plattenelements und Drücken des zweiten Plattenelements (3) gegen das erste Plattenelement (2) zum Hervorrufen eines plastischen Fließens des Materials des zweiten Plattenelements in die Nuten (7) des ersten Plattenelements (2) zum Füllen der Nuten mit dem Material des zweiten Plattenelements,
dadurch gekennzeichnet,
daß das zweite Plattenelement (3) aus einem Material gebildet wird, das weicher ist als das Material des ersten Elements (2), wobei die Vorsprünge (9) zur Bildung einer V-Form im Querschnitt nach unten konvergieren, daß eine mittlere Rippe (28) mit einander entgegengesetzten, schräg verlaufenden Seitenflächen auf sowie entlang des Bodens einiger der Nuten (7) derart ausgebildet wird, daß ein Paar Nuten V-förmigen Querschnitts gebildet wird, die sich in dem ersten Plattenelement schräg in Richtung voneinander weg erstrecken, und daß das plastische Fließen des weicheren Materials des zweiten plattenelements (3) in jede Nut (7) hinein als Ergebnis der Druckbeaufschlagung des zweiten Plattenelements (3) sowie unter der Führung der einander entgegengesetzten, schräg verlaufenden Seitenflächen der Rippe (28) in zwei Flüsse in das Paar Nuten V-förmigen Querschnitts hinein aufgeteilt wird.

Revendications

1. Une structure composite réalisée à partir d'une paire d'éléments plats réunis mécaniquement ensemble, comprenant :
un premier élément plat (2) présentant une première surface plane de liaison (11a) munie de rainures (7) réparties sur la surface, au moins l'une desdites rainures (7) ayant des surfaces latérales inclinées opposées (6) ; et
un second élément plat (3) muni d'une seconde surface plane de liaison (11b) reliée face-à-face à ladite première surface de liaison (11a), ladite seconde surface de liaison présentant des saillies (9) en faisant partie intégrante et amenées plastiquement à force dans lesdites rainures respectives (7) pour les remplir et

venir fermement en contact avec elles,
caractérisée en ce que
ledit second élément plat (3) est réalisé en une matière plus molle que la matière du premier élément plat (2), en ce qu'au moins certaines des rainures (7) sont formées pour présenter une arête intermédiaire (28) sur le fond de la rainure, ladite arête (28) présentant des surfaces latérales opposées inclinées pour définir, avec lesdites surfaces latérales inclinées opposées (6), une paire de rainures de section latérale en forme de V, s'étendant dans le premier élément plat (2) de manière oblique dans des directions éloignées l'une de l'autre, et les saillies du second élément plat (3) comprenant des saillies (9) convergeant vers le bas pour délimiter en section droite une forme en V et faisant saillie dans des rainures correspondantes (7).

2. La structure composite selon la revendication 1,
caractérisée en ce que
lesdites rainures (7) et arêtes présentent sur leurs surfaces de fins évidements et de fines saillies de forme ondulée.

3. La structure composite selon la revendication 1,
caractérisée en ce que
ladite surface de liaison desdits premier et second éléments plats (2, 3) présente au moins en partie de fins évidements et de fines saillies de forme ondulée.

4. La structure composite selon la revendication 1,
caractérisée en ce que
lesdites surfaces de liaison, lesdites surfaces internes desdites rainures (7) et lesdites surfaces externes desdites arêtes sont réunies l'une à l'autre à l'aide d'une mince pellicule (11) interposée entre elles.

5. La structure composite selon la revendication 4,
caractérisée en ce que
la mince pellicule est un revêtement anti-corrosion.

6. La structure composite selon la revendication 1,
caractérisée en ce qu'elle
comprend des bords latéraux ondulés (16) formés le long de l'ouverture de chacune desdites rainures (7) en tant que prolongements de ladite première surface de liaison.

7. Un procédé de fabrication d'une structure composite réalisée à partir d'une paire d'éléments plats (2, 3) reliés mécaniquement ensemble, comprenant les opérations consistant à :
préparer un premier élément plat (2) présentant une première surface plane de liaison (11a) munie de rainures (7) réparties sur la surface, au moins certaines desdites rainures (7) ayant des surfaces latérales inclinées opposées (6) ;
préparer un second élément plat (3) présentant une seconde surface plane de liaison (11b) ayant des saillies en faisant partie intégrante ;
mettre l'une en face de l'autre les première et seconde surfaces de liaison (11a, 11b) du premier et du second élément plat, et presser le second élément plat (3) contre le premier élément plat (2) afin d'amener un fluage de la matière du second élément plat dans les rainures (7) du premier élément plat (2) afin de remplir les rainures avec la matière du second élément plat,
caractérisée en ce qu'on
prévoit le second élément plat (3) d'une matière plus molle que la matière du premier élément (2), dans lequel lesdites saillies (9) convergent vers le bas pour délimiter en section droite une forme en V, une arête intermédiaire (28) présentant des surfaces latérales opposées inclinées étant formée sur et le long du fond desdites certaines rainures (7) afin de définir une paire de rainures de section droite en forme de V, s'étendant dans le premier élément plat de manière oblique dans des directions éloignées l'une de l'autre, et en ce que ledit fluage de la matière plus molle du second élément plat (3) dans chaque rainure (7) est divisé en deux dans ladite paire de rainures de section droite en forme de V, à la suite dudit pressage du second élément plat (3), sous le guidage desdites surfaces latérales inclinées opposées de l'arête (28).

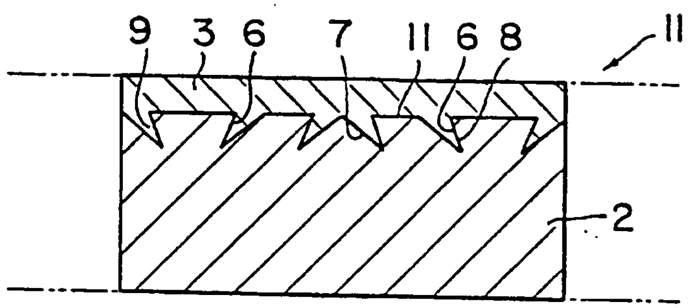


FIG. 1A

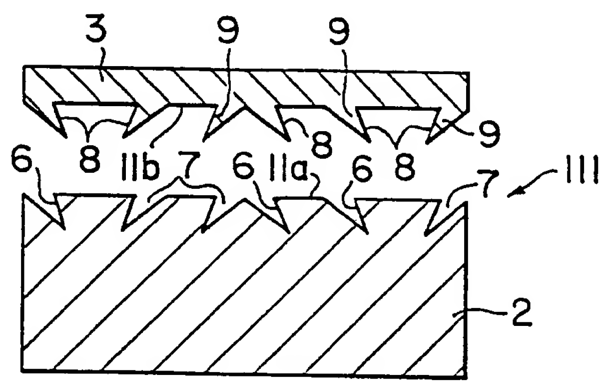


FIG. 1B

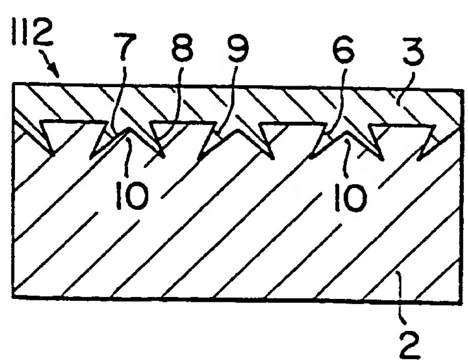


FIG. 2

FIG. 3

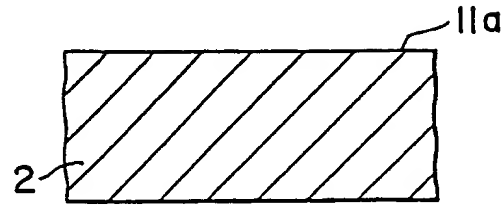


FIG. 4

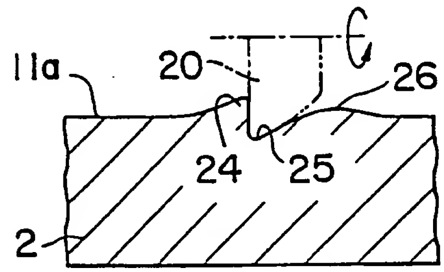


FIG. 5

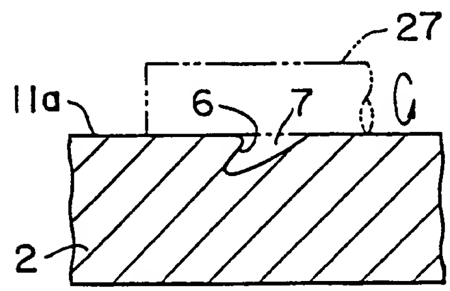


FIG. 6

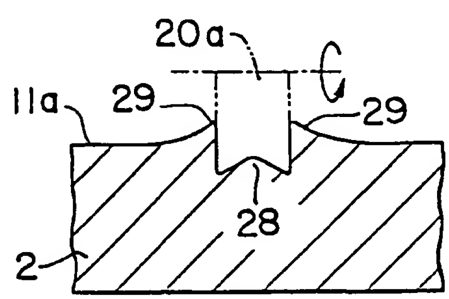
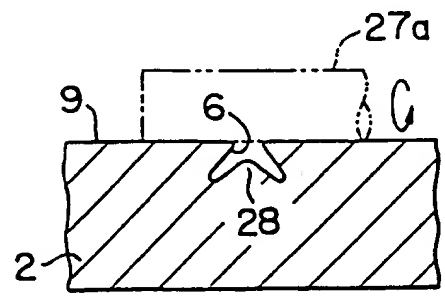


FIG. 7



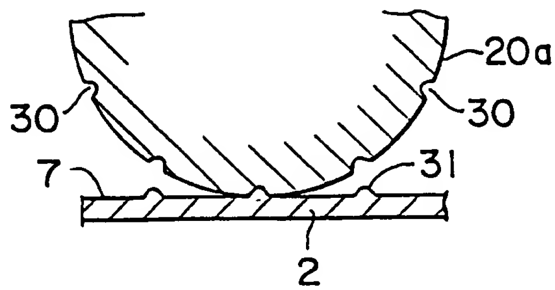


FIG. 8

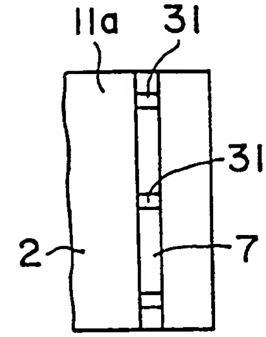


FIG. 9

FIG. 10

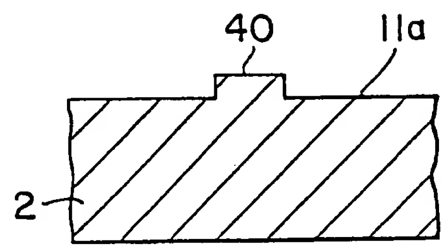


FIG. 11

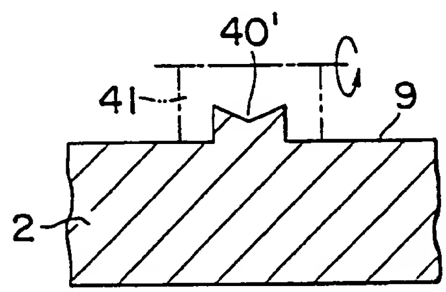
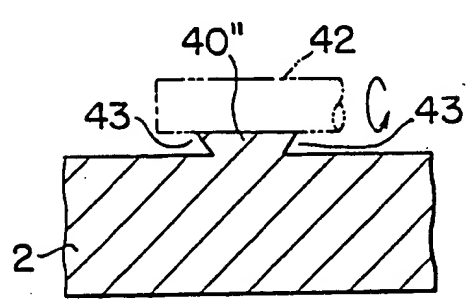


FIG. 12



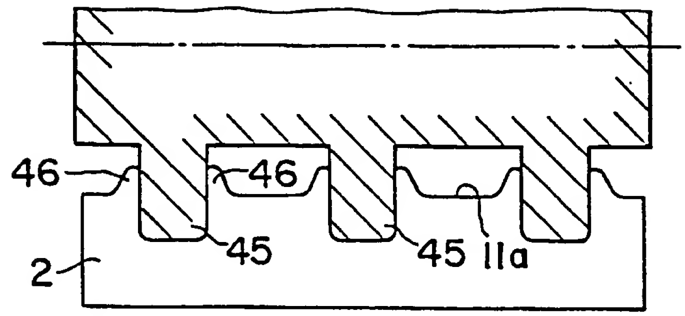


FIG. 13

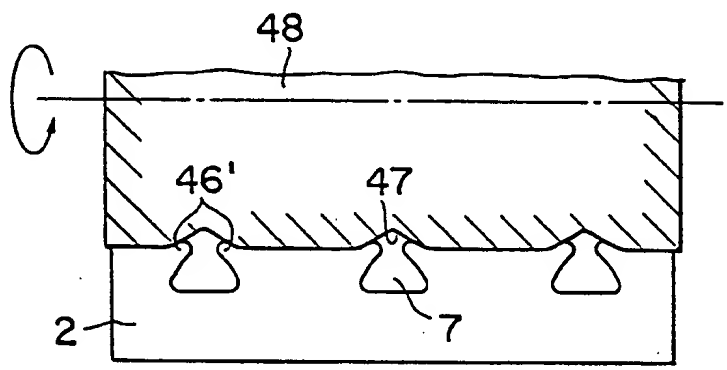


FIG. 14

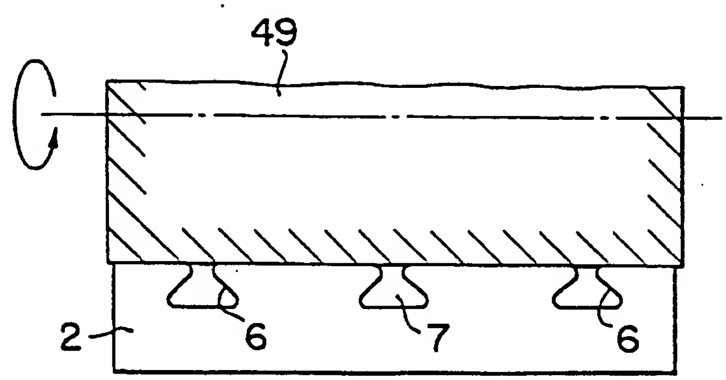


FIG. 15

FIG. 16

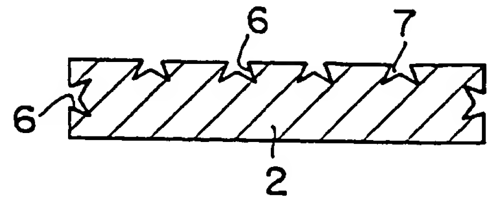


FIG. 17

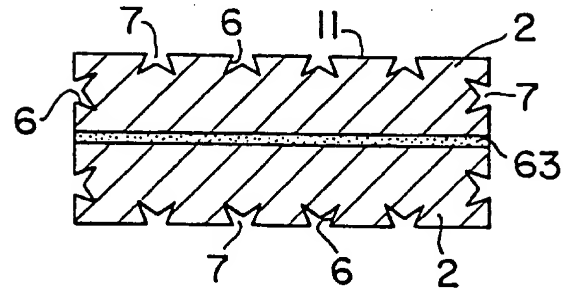


FIG. 18

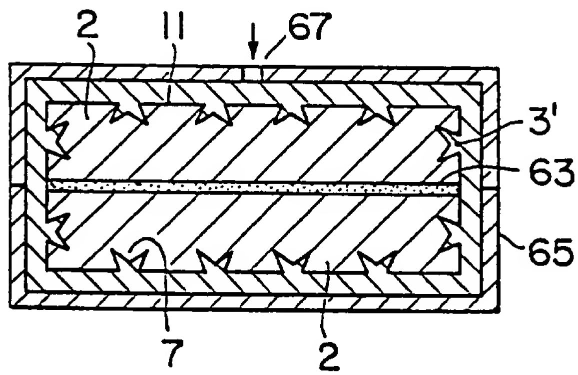


FIG. 19

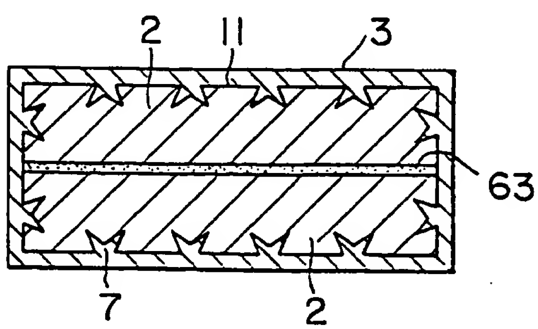
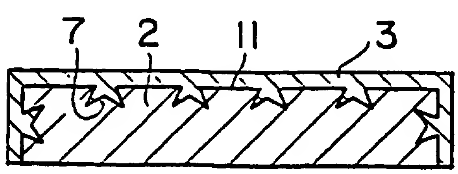


FIG. 20



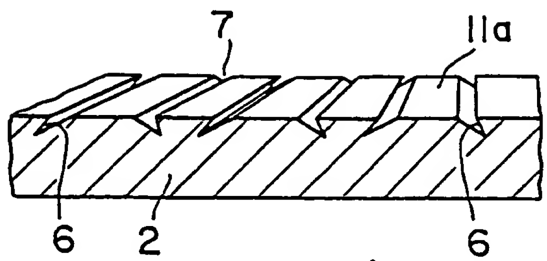


FIG.21

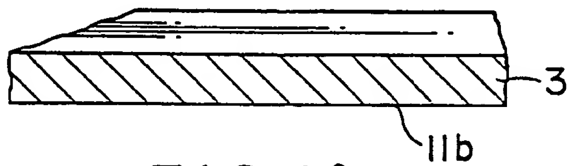


FIG.22

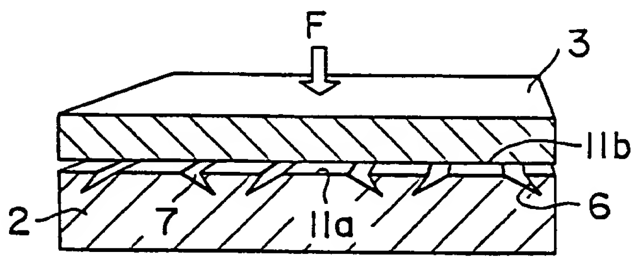


FIG.23

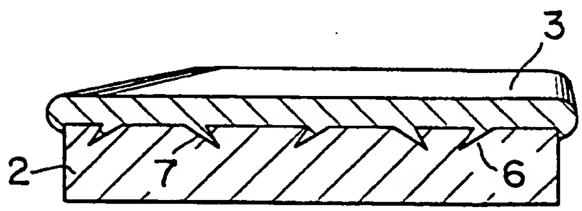


FIG.24

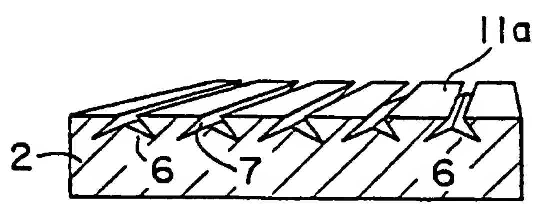


FIG.25

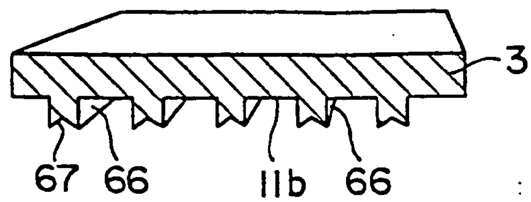


FIG. 26

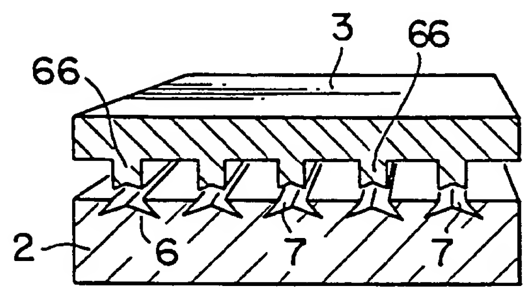


FIG. 27

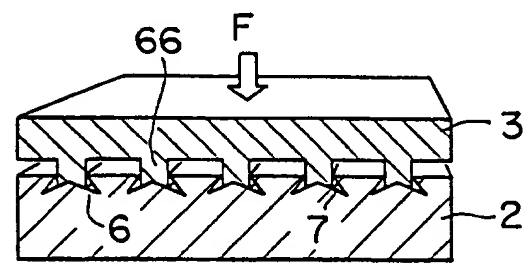


FIG. 28

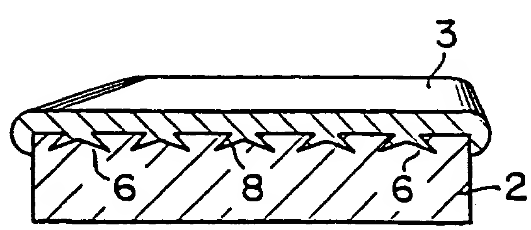


FIG. 29